

BRIGHAM CITY LIGHT AND POWER

FIVE YEAR PLAN

Introduction

The Brigham City Electrical System Five Year Plan has been developed in an effort to provide the City with a plan and cost estimate for electrical improvements that need to be undertaken during the next five years. Unlike the 20 year plan which provided a general outline for work that needs to be undertaken over a relatively long period of time and which may vary somewhat in timing and actual construction, the five year plan focuses on capital improvements that are required in the short term.

Normally, the planning and engineering phases of an electrical project may take one to six months. The procurement of electrical materials, depending on market demands, may take four to twelve months. Finally, the construction of the projects may take from one month for minor projects, to four months for moderate sized projects to a year or more for large projects. All of the projects in this plan are in the small to moderate range in size. Therefore, engineering, material procurement and construction for each projects in the five year plan can reasonably be completed in a twelve month time period. However, budget considerations may dictate that material for a project should be procured during one budget year and construction may follow during the following budget year.

This report will address the following:

- Electrical projects that are required
- Approximate project schedules for each project
- An engineering cost estimate for each project
- Annual costs to complete the entire 5 year plan

It should be noted that most of the work proposed in this 5 year plan is to be performed in the East Substation. East Substation is the heart of the Brigham City electrical system and is critical to the safe and reliable operation of the electric system. Without this critical facility, the City is without power and most activities will cease. That includes water, sewer, school and most business activities. Furthermore, loss of primary power to hospitals, traffic signals and alarm systems may significantly burden law enforcement, fire protection and other emergency agencies in carrying on their normal activities.

East Substation 46 kV Breaker Replacement

East Substation has three 46 kV breakers that are used for delivering power to the City. (See Figure 1 which shows one of the three breakers in the upper portion of the picture. The box in the lower portion of the picture is the control cabinet.) The three breakers are 25 years old and are in marginal condition. During the last few years, components of the breakers have failed. Spare parts are non-existent and there is no support from the original manufacturer. Presently the breakers are scheduled to be replaced over the next three years. It is advisable that all three breakers be replaced on an expedited schedule.

The following is a cost estimate for replacing the three, 46 kV breakers:

• Three, 46 kV breakers @ \$40, 000 each	\$120,000
• Three concrete foundation modifications @ \$5000 each	\$ 15,000
• Control Wiring for three breakers @ \$3500 each	\$ 10,500
• Bus modifications @ \$5000 each	\$ 15,000
• Installation of three 46 kV breakers @ \$6500 each	\$ 19,500
• Testing and Commissioning @ \$3000 each	\$ 9,000
• Engineering @ \$5000 each	\$ 15,000
• Contingency	\$ 16,000

Total Estimated Cost	\$220,000
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Failure of any one of the three circuit breakers will place a portion of the City without power. Restoration of service due to that outage is somewhat dependent on the mode of failure of the breaker. In most cases, restoration of service could be completed within three hours due to the flexibility of switching the 46 kV transmission lines and 12 kV feeder breakers. A catastrophic failure of a 46 kV breaker could take out the entire City for 12 hours or more.

East Substation 138 kV Breaker Replacement

The East Substation, 138 kV oil circuit breaker at the present time is most likely the most critical device in the electrical system. (See Figure 2) With the exception of the three relatively small hydro units, all of the power flows through that breaker to the City. Several catastrophic failures of that type of breaker have occurred across the United States. As can be seen in Figure 1, the breaker consists of three, oil filled interrupters. An electrical failure internally to one of the tanks has the capability of blowing the access-covers from the tank, spewing oil in the substation and resulting in a significant fire. Failure of that circuit breaker could result in a total outage to City for a substantial amount of time. This breaker is a weak link in the City's ability to deliver power to its customers. Depending on the type of failure to the breaker, the entire City could be without power from several hours to several days. This is an unacceptable condition.



Figure 1: East Substation – Obsolete 46 kV Circuit Breaker

The following is a cost estimate for the replacement of the 138 kV breaker:

• One, 138 kV, 1200 Amp Circuit Breaker	\$ 80,000
• Concrete foundation modifications	\$ 10,000
• Control Wiring replacement	\$ 5,000
• Relaying modifications/replacement	\$ 10,000
• Installation	\$ 10,000
• Bus modifications	\$ 3,000
• Installation	\$ 10,000
• Testing and Commissioning	\$ 7,000
• Engineering	\$ 15,000
• Contingency	\$ 15,000
Total Estimated Cost	\$165,000

The replacement circuit breaker would most likely utilize an insulating gas for interruption rather than oil. The use of a gas would greatly improve the environmental aspects of the breaker over the present use of oil as an interrupting means. Also, the probability of a fire is greatly reduced with the use of a gas rather than a oil.

East Substation - Replacement of Two 138 kV Load Interrupter Switches

The 138 kV transmission line switches at the East Substation need to be replaced with load interrupters. The existing switches are marginal, require a lot of maintenance and have a tendency to mis-operate. These switches are critical to Utah Power and Light's 138 kV transmission system as well as Brigham City's power delivery system.

The following is a cost estimate for the installation of the 138 kV Load interrupters:

• Two, 138 kV load interrupters @ \$30,000 each	\$60,000
• Steel Modifications @\$10,000 each	\$20,000
• Installation and testing @ \$5,000 each	\$10,000
• Engineering	\$ 5,000
Total Estimated Cost	\$95,000

The installation of the load interrupter switches will provide a safer means of switching the incoming 138 kV lines. It may also be possible to provide automatic controls to these devices to help restore service to the City when Utah Power and Light has transmission line problems.



Figure 2: East Substation 138 kV Oil Circuit Breaker

East Substation Relaying and Control Modifications

The relaying and control panels at East Substation are approximately 25 years old and require a substantial amount of maintenance on an annual basis. (See Figures 3 and 4) The protective relays are older, discrete electromechanical relays with the exception of the 44 kV breakers. The 46 kV breaker relays were replaced with modern day, SEL-551 relays (the small blue devices in Figure 4) several years ago. The relay replacement project should be scheduled with the other modifications taking place at East Substation such as the replacement of the 46 kV and 138 kV breakers.

The cost estimate for the replacement of the relays is:

• Two sets of transformer relays @ \$7500 each	\$15,000
• Miscellaneous test switches and panels	\$ 5,000
• Installation	\$10,000
• Testing and commissioning	\$ 5,000
• Engineering	\$10,000
• Contingency	\$ 5,000

Total Estimated Cost	\$50,000
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In comparison with the other items being considered for replacement at East Substation, the relaying and control modifications are the least critical. However, good engineering practice suggests that the relaying and control should be upgraded with the other modifications to the substation. Otherwise, replacing the other equipment in the substation without changing out the controls and relaying would be like changing a 25 year old furnace in a house without changing out the 25 year old thermostatic controls.

Relay Replacement at Northwest, Southwest and West Substations

The protective relaying systems at Northwest, Southwest and West Substations (See Figure 5) should be upgraded to microprocessor based, multi-function relays. The existing discrete Basler relays have been problematic during the last few years and should be replaced.

The following is a cost estimate for the relay replacement at each of those substations:

• Protective Relays @ \$4500 each	\$13,500
• Installation @ \$2500 each	\$ 7,500
• Testing and commissioning @ \$1500 each	\$ 4,500
• Engineering @ \$1500 each	\$ 4,500
• Contingency	\$ 5,000

Total Estimated Cost	\$35,000
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Figure 3: East Substation – 138 kV & 46 kV Control Panels



Figure 4: East Substation – 138 kV & 46 kV Relaying Panels



Figure 5: Typical – Northwest/Southwest/West Substation Relay Panel

Proposed Project Schedule

All of the proposed improvements at East Substation are high priority items and should be installed as quickly as possible. In addition, all of these items should be completed within the next five years. With that in mind, the following schedule is proposed for the work to be completed:

2004

Engineering for the following should be completed:

- Three 46 kV Breakers

2005

Engineering for the following should be completed:

- East Substation 138 kV Circuit Breaker
- East Substation 138 kV Load Interrupters
- East Substation Relay replacement

Procurement of:

- Three 46 kV Breakers
- East Substation Relays and Control

Installation of:

- One 46 kV Circuit Breaker

2006

Engineering for the following projects should be completed:

- Northwest Substation relay replacement
- Southwest Substation relay replacement
- West Substation relay replacement

Installation of:

- Two 46 kV Circuit Breakers
- East Substation Relays

Procurement of:

- One, 138 kV Circuit Breaker at East Substation
- Northwest Relays
- Southwest Relays
- West Relays

2007

Procurement of:

- Two, 138 KV Load Interrupter Switches

Installation of:

- One, 138 kV Circuit Breaker at East Substation
- Northwest Substation Relays
- Southwest Substation Relays
- West Substation Relays

2008

Installation of:

- Two, 138 kV Load Interrupter Switches at East Substation

Summary and Conclusions

A five year plan for the electric utility system has been developed for the City. For the most part, the plan calls for the upgrading of the East Substation. East Substation is the heart of the electric system, is over 25 years old and is a critical component to the reliable operation of the electric system.

During the next five years, the following projects need to be completed:

1. East Substation 46 kV Breaker Replacement	\$220,000
2. East Substation 138 kV Breaker Replacement	\$165,000
3. East Substation Load Interrupters	\$ 95,000
4. East Substation Relaying and Control Upgrade	\$ 50,000
5. Northwest/Southwest/West Relay Replacement	\$ 35,000
Total Estimated Costs	\$565,000

A schedule has been developed to engineer and construct the proposed capital improvements. Most of the work will be performed at the East Substation with some minor work taking place at Northwest, Southwest and West Substations. The proposed expenditures in 2004 dollars are estimated to occur as follows:

<u>Calendar Year</u>	<u>Expenditure</u>
2004	\$ 25,000
2005	\$160,000
2006	\$150,000
2007	\$150,000
2008	\$ 80,000
Total Expenditures	\$565,000

It should be stressed that the items listed in the plan are the minimum requirements for the continued reliable operation of the City's electrical system. Furthermore, if these items could be completed in a shorter time period, that should be done. Under no circumstances should any of the items in the five year plan be delayed.

John P. Nelson, P.E.
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